

## **REMARKS**

### **Examiner Interview:**

Applicants thank the Examiner for the courtesies extended to an inventor, James Snyder, and their representatives, Chung Park and Claude Hamrick, during the telephone interview on March 13, 2007. In particular, Applicants thank the Examiner for indicating that he would give favorable consideration to Applicants' further amendments and remarks in connection with this application.

### **The Claims:**

Claims 1-64 are currently pending. Claims 1, 24, and 35 have been amended to respectively incorporate the subject matter of claims 2-4, 25-27, and 36-38, and claims 2-4, 25-27, and 36-38 consequently being canceled. Claims 8, 17, 18, 19, 39, 40, 41, and 43 have been amended in light of the changes made to claims 1 and 35. Claims 48, 52, 59, and 62 has been amended to correct minor informality. Claim 44 has been amended for clarity. Applicants respectfully request reconsideration of the application in response to the non-final Office Action.

### ***Allowable Subject Matter***

Applicants gratefully acknowledge the indication by the Examiner that claims 20-23, 59, and 60 would be allowable if rewritten in independent form to include all of the limitations of the base claims and intervening claims.

***Claim Objections***

Claim 62 has been amended to correct minor informality. Withdrawal of the objection is respectfully requested.

***Claim Rejections – 35 U.S.C. §101***

Claims 24-30, 32-34, and 62 have been rejected under 35 U.S.C. §101 because the claimed invention is allegedly directed to non-statutory subject matter.

In rejecting claims, the Office has stated that "[t]he claim must have either physical transformation and/or a useful, concrete and tangible result. The claims fail to include transformation from one physical state to another. Although the claims appear useful and concrete, a tangible result is not claimed."

Claim 24 is directed to measuring wavelength of an input light beam by use of wavemeters depicted in FIGS. 2, 5, and 6, for instance. For emphasis of the original claim recitations, claim 24 has been amended to recite

24. A method for measuring the wavelength of an input light beam *by use of a wavemeter*, the method comprising:  
launching the input light beam into a waveguide *of the wavemeter*;

\* \* \*

determining, *by use of a processor of the wavemeter*, an average period of fringes and the phase of a selected fringe of the detected fringe pattern;

\* \* \*

*causing the wavemeter to provide information of the determined wavelength to a user.* (Emphasis added)

Support for the change can be found in the specification, at page 1, paragraph [0002], page 5, paragraphs [0015] - [0019], and page 9, paragraph [0030], for instance. The final step of amended claim 24 is directed to making use of the

determined wavelength such that a practical application is realized, making the result achieved by the claimed invention be tangible. Also, as correctly noticed by the Office, claim 24 generates useful and concrete results. Accordingly, Applicants respectfully submit that the claimed invention is directed to statutory subject matter, and claim 24 is allowable. Claims 28-30, 32-34, and 62 depend from claim 24, rendering them also allowable. Withdrawal of the rejection of claims 28-30, 32-34, and 62 is respectfully requested.

***Claim Rejections – 35 U.S.C. §103***

Claims 1-19, 24-43, and 61-63 have been rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Leuchs et al. (US Patent 5,172,185) in view of Kaufman et al. (US Patent 3,493,288) and Kachanov (US Patent 5,543,916). This rejection is respectfully traversed.

In rejecting claims 1 and 35, the Office has stated that:

Leuchs et al. (Leuchs hereinafter) show a device for determining the wavelength of laser light in Figure 2 comprising:  
an optical device having an input port (e.g. entrance to fibers 3 and 4) and two ports (e.g., 3a, 4a) ...  
\* \* \*

a processor (13) implementing a process for analyzing said one or more detection signals to thereby control the wavelength of the input light beam

Although the embodiment of Figure 2 appears to show that the physical path 4' is longer than path 3' since the exit end of path 4' is further away than the exit end of 3' from their respective entry ends, Leuchs does not clearly show or state that the first and second optical paths have a physical pathlength difference. However, if the pathlength of 4' is identical to 3', one of ordinary skill in the art at the time of the invention would have made the physical pathlength of 4' to be different from 3' for the following reasons:

Leuchs suggests that having a pathlength (phase) difference between the two is desired in order to make it easier to detect

interference (column 3, lines 17 and 18), and Leuchs shows two examples how to achieve this as shown in Figures 3 and 4. Leuchs however does not show an example by making the physical length of one path longer of [sic] than the other path.

Kaufman et al. (Kaufman hereinafter) show an interferometer where a phase between the beams in [sic] introduced by making the beams travel a different path length. The input and output ports are located in a common plane normal to the direction of propagation of the central light rays. Furthermore, Official Notice is given that it is well known in interferometry to introduce a pathlength difference by making one path physically longer than the other....

Therefore, at the time of the invention, one of ordinary skill in the art would have modified the interferometer of Leuchs so that the physical pathlength of 4' is different from 3' in order to have a more compact interferometer as shown by Kaufman.

\* \* \*

Leuchs ... does not expressly state that the wavelength is calculated although suggesting the wavelength can be calculated.

Kachanov shows an interferometer for determining wavelength wherein the interferometer uses two point sources of light similar to Leuchs' fiber ends to create an interference pattern. Kachanov further shows CCD detector and a more complex processor than Leuchs' comparator by using a computer (140) to determine the wavelength.

At the time of invention, one of ordinary skill in the art would have modified Leuchs with Kachanov's CCD detector and computer in order to obtain more information regarding the wavelength of the light since a CCD can obtain the full range of the interference fringes and the computer can do the [sic] perform the calculation automatically from the signals obtained by the CCD.

Applicants respectfully disagree. The Leuchs systems are directed to locking the wavelength of a laser to a particular value, but are not suited to finding the actual value of the wavelength. In particular, Leuchs' Figures 1, 2, and 5 show wavelength-locking interferometers consisting of fibers 2, 5, and 6 (2', 5' and 6' in Figure 2) optically connected to a moveable, triple mirror 11. The motion of the triple mirror 11 causes the fringe pattern detected by the photodetector(s) 12 to change. The change of the fringe pattern is related both to the laser wavelength and to the amount of

motion of the triple mirror 11. The wavelength is locked by the interferometer consisting of fibers 3 and 4 (3' and 4'), which generate a fringe pattern detected by the photodetectors 8a and 8b (8). By controlling the laser wavelength, so that the fringe pattern detected by photodetectors 8a and 8b (8) does not change, the wavelength is locked to a constant value and the change of the fringe pattern detected by photodetector(s) 12 is related only to the motion of the triple mirror 11.

As shown in Figures 1 and 5 of the Leuchs patent, the wavelength locking interferometer having fibers 3 and 4 could not be used to measure the value of the wavelength of the laser to a useful accuracy. This is because, as set forth below, the optical path difference between fibers 3 and 4 needs to be approximately zero for proper operation, and the fringe pattern would not be sufficiently sensitive to any change in the wavelength. For similar reasons, the wavelength locking interferometer shown in Figure 2 could not be used to measure the value of the wavelength of the laser to a useful accuracy.

In Figures 3 and 4 of the Leuchs patent, the wavelength locking interferometers are modified to introduce an optical path difference in the two arms of the interferometers. This increased optical path difference might increase the sensitivity of the interferometer to small changes in the wavelength. However neither configuration would be suitable for measuring the wavelength value since the positioning of the two emitting apertures (the ends of the fibers or waveguides) are in substantially different planes, and the fringe patterns from both interferometers would be oval in shape and have non-uniform fringe spacing. As such, the oval-shaped fringe pattern would be very difficult to analyze by any mathematical approach, and impossible to analyze using the approach of the present disclosure.

In each of Leuchs' systems, the wavelength locking interferometer has a pair of optical fibers or waveguides of substantially equal length. This is necessary because the interferometer of the Leuchs systems needs to be sensitive only to the laser wavelength in air. In order to minimize any sensitivity of the interferometer to the index of refraction of the optical fibers or waveguides, each pair of optical fibers needs to be of nearly equal length so that any effect due to the change in the index of refraction of the optical fibers is compensated. As a result, the Leuchs systems are either too insensitive to the wavelength to be useful as a wavelength meter, or the fringe pattern is too complex to be amenable to calculation of the wavelength.

As correctly noted by the Office, Leuchs fails to teach that two optical paths 3', 4' have a physical difference. However, as discussed above, if any optical path difference exists between the two optical paths 3', 4', the spatial fringe pattern would be affected by the temperature of the paths 3', 4' or substrate 17, i.e., additional parameters affecting the pattern would be introduced in the systems. As a consequence, the spatial fringe pattern cannot be used to control the air wavelength of the laser diode unless the effects of the additional parameters are compensated. Leuchs does not disclose any measure to compensate the effects, which therefore requires that the two optical paths of the Leuchs system have the same optical path length for proper operation. In Figures 3 and 4 of Leuchs, the two output ports have different distances from the photodetector units 8a, 8b (col. 3, l. 17-18). It appears that the Office has mistakenly equated this difference to the pathlength difference between the two optical paths 3' and 4'. However, a review of the Leuchs reveals that Leuchs is silent as to the pathlength difference between the two optical paths

3',4', much less the wavelength measurement based on the pathlength difference between the two optical paths 3', 4' as disclosed in the present disclosure.

The Office has relied upon Kaufman and Official Notice to overcome the deficiency in teaching the optical pathlength difference between the first and second optical paths as defined in claim 1. Kaufman discloses a system having multiple pipes with different optical path lengths. As such, even if one were to assume that the multiple pipes of the Kaufman system were used in the Leuchs systems, the hypothetical combination would not work properly since the optical pathlength difference between multiple pipes would require an additional measure to compensate the effects of the additional parameters on the spatial fringe pattern as discussed above. In addition, the dimensions of the Kaufman and Leuchs systems are not specified in these patents. As such, it is not clear how the hypothetical combination would be a more compact interferometer as asserted by the Office (Office Action, page 5, paragraph 3), let alone how the purportedly compact system would compensate the effects of the additional parameters on the spatial fringe pattern. Likewise, if one were to modify the Leuchs system to incorporate the features of the Official Notice, the hypothetical combination would not work properly based on the same reasons. In this regard, Kachanov is similar in nature. Kachanov is relied on to overcome the deficiency in teaching wavelength determination. However, the Kachanov system has only one aperture, and thereby Kachnov fails to teach or suggest the pathlength difference between two optical paths that are respectively formed between an input port and two output ports, much less determining wavelength based on the optical pathlength difference using the approach of the present disclosure. In fact, none of the cited references, taken

individually or in combination, teach or suggest that the pathlength difference between two optical paths formed between an input port and two output ports generates fringe patterns to be used for wavelength measurements. Instead of measuring wavelength, the Leuchs and Kaufman patents are directed to changing the wavelength of the light sources.

In sum, if one were to read the cited references and the Official Notice without the benefits of Applicants' own disclosure, one would see that they are incompatible with one another and that there is no reason to modify one to reflect features of the other to arrive at Applicants' claimed invention. Only through impermissible and improper hindsight reconstruction has the Office Action been able to pick and choose among isolated disclosures in the prior art in an attempt to arrive at Applicants' claimed invention. It is well settled that such hindsight reconstruction is improper. As such, Applicants respectfully submit that a *prima facie* case of obviousness has not been established, and claims 1 and 35 are patentable.

For emphasis of the original claim recitations, claims 1 and 35 have been amended to recite:

1. An apparatus for measuring the wavelength of an input light beam, the apparatus comprising:

\* \* \*

a processor responsive to said detection signals and operative to:

determine an average period of the fringes evidenced by said detection signals and the phase of a selected fringe evidenced by the detection signals;

determine an exact order number of the light to a reference point on said photo detector based on the average period and phase;

determine an optical delay of said first optical length difference at said reference point; and

divide said optical delay by said exact order number to get the wavelength of the input light beam.

35. An apparatus for measuring the wavelength of an input light beam, the apparatus comprising:

\* \* \*

means for determining an average period of fringes of the fringe pattern and the phase of a selected fringe of the fringe pattern and for calculating the wavelength of the input light beam based on the average period of the fringes and phase.

Support for the recitations added to claims 1 and 35 can be found in canceled claims 2-4 and 36-38 and in the specification, at page 10, paragraphs [0032] - [0033]. A through review of the Leuchs, Kaufman, and Kachanov patents are silent as to the recitations, rendering claims 1 and 35 patentable.

In addition, a declaration under 37 CFR 1.132 for Objective Evidence of Nonobviousness is enclosed herewith. The declaration states that the technical paper, "Wavelength measurement with a Young's interferometer", Optical Engineering 44(8), August 2005, is authored by the inventors of the present application and discloses inventive information concerning the inventions of claims 1, 24, 35, and 44, and was recognized for its innovative advancement of existing wavelength measurement technologies, and as such was awarded the 2005 Rudolf Kingslake Medal and Prize. Applicants respectfully submit that the paper provides an objective evidence of peer and industry recognition of the nonobviousness of the invention. Applicants therefore respectfully request that the paper be considered in determining the issue of obviousness of claims 1, 24, 35, and 44 under 35 U.S.C. §103(a).

Claims 5-19, 39-43, 61, and 63 depend from claims 1 and 35, rendering them also patentable for at least the same reasons. In addition, it is noted that the dependent claims add features which further remove the present invention from the

applied art. For instance, claims 6, 7, and 42 respectively include recitations: "a heat sink in thermal communication with optical waveguide," "the temperature of the optical waveguide is actively and/or passively regulated through the heat sink," and "means for actively and/or passively regulating the temperature of the two paths." However, both Leuchs and Kachanov are silent as to heat sinks and means for regulating the temperature of the two paths. Also, the Official Notice fails to provide any evidence that teaches or suggests the features recited in claims 6, 7, and 42.

For another instance, in rejecting claim 10, the Office has stated that "one of ordinary skill in the art would have optimized for the proper working range of knowing the relationship of the fringe spacing to the wavelength, pathlength difference, point source distance, and the distance to the observation plane as is know by the teaching of Young (Young disclosed by Applicant's disclosure)." Applicants respectfully disagree. Claim 10 includes a recitation "the first optical length difference is a physical length difference of about 2.33 mm." This length difference generates phase difference before the light beams exit the two output ports. As such, this length difference has little to do the teachings of Young.

For still another instance, in rejecting claims 61 and 63, the Office has stated that "Leuchs shows the pathlength differences in Figure 3 and 4 to be a significant difference and appears to be more than 1 mm." Applicants respectfully disagree. To the careful reading of the undersigned, Leuchs does not disclose that Figures 3 and 4 of Leuchs are scaled drawings. Even if one were to assume, *arguendo*, that these figures are scaled drawings, the pathlength difference in Figures 3 and 4 refers to

the pathlength difference between the output ports and photodetectors, not the path length difference between the optical paths 3' and 4'.

Claim 24 has been rejected based on the same reasons as those advanced against claims 1 and 35. Claim 24 is directed to a method for measuring wavelength by use of the devices recited in claims 1 and 35, for instance. Applicants repeat the argument with regard to the cited references as set forth above to address the rejection of claims 1 and 35, and respectfully submit that a *prima facie* case of obviousness has not been established, and claim 24 is patentable. It is also noted that the subject matter of claim 24 is disclosed in the paper recited in the attached declaration under 37 CFR 1.132 for Objective Evidence of Nonobviousness.

For emphasis of the original claim recitations, claim 24 has been amended to recite:

24. A method for measuring the wavelength of an input light beam by use of a wavemeter, the method comprising:

\* \* \*

determining, by use of a processor of the wavemeter, an average period of fringes and the phase of a selected fringe of the detected fringe pattern;

analyzing the average period and phase to thereby determine the wavelength of the input light beam; and

causing the wavemeter to provide information of the determined wavelength to a user.

Support for the recitations added to claim 24 can be found in canceled claims 25-27 and in the specification, at page 10, paragraphs [0032] - [0033]. Based on the declaration and the same reasons set forth above to address the rejection of claims 1 and 35, Applicants respectfully submit that a *prima facie* case of obviousness has not been established, and claim 24 is patentable.

Claims 28-34 and 62 depend from claim 24, rendering them also patentable for at least the same reasons. In addition, it is noted that the dependent claims add features which further remove the present invention from the applied art. For instance, claim 31 includes a recitation "actively and/or passively regulating the temperature of the two paths." However, both Leuchs and Kachanov are silent as to regulating the temperature of the two paths. Also, the Official Notice fails to provide any evidence that teaches or suggests the features recited in claim 31. For another instance, with regard to claim 62, Applicants repeat the same argument as set forth above to address the rejection of claim 61.

Claims 44-58 has been rejected under 35 U.S.C. 103(a) as being allegedly unpatentable over Leuchs et al. (US Patent 5,172,185), Kaufman et al. (US Patent 3,493,288), Kachanov (US Patent 5,543,916) as applied to claim 1 above, and further in view of Snyder (U.S. 4,173,442). This rejection is respectfully traversed.

In rejecting claim 44, the Office has stated that "Leuchs, Kaufman, and Kachanov show all the elements but does not expressly show the process of determining the order number of the light to a reference point and the optical delay." Then, to overcome the deficiency in teaching the process of determining the order number, the Office has relied on the Snyder patent. Applicants respectfully disagree.

Based on the same reasons set forth above to address the rejection of claim 1, Applicants respectfully submit that Leuchs, Kaufman, and Kachanov fail to teach or suggest, taken individually or in combination, the recitations of claim 44: "an optical device having an input port and two output ports ... a photo detector adapted to generate one or more detection signals ... a processor implementing a process for

analyzing the one or more detection signals to thereby determine the wavelength of the input light beam...." The Snyder patent is also silent as to the recitations. As such, Applicants respectfully submit a *prima facie* case of obviousness has not been established, and claim 44 is patentable.

For emphasis of the original claim recitations, claim 44 has been amended to recite:

44. An apparatus for measuring the wavelength of an input light beam, the apparatus comprising:

\* \* \*

determining the average spacing between fringes and computing therefrom a preliminary wavelength of the light;

determining the phase and computing the exact order number of the light to a reference point on said photo detector based on the phase;

determining an optical delay of said first optical length difference at said reference point on said photo detector; and

computing from said exact order number and said optical delay the wavelength of said input light beam.

Support for the recitations added to claim 44 can be found in the specification, at page 10, paragraphs [0032] - [0033]. Based on the attached declaration and the same reasons set forth above to address the rejection of claims 1 and 35, Applicants respectfully submit that a *prima facie* case of obviousness has not been established, and claim 24 is patentable.

Claims 45-58 depend from claim 44, rendering them also patentable for at least the same reasons. In addition, it is noted that the dependent claims add features which further remove the present invention from the applied art. For instance, Applicants respectfully submit that claims 46, 47, 50, and 64 are patentable for the same reasons set forth above to address the rejections of claims 6, 7, 10, and 61.

***Conclusion***


Based on the reasons as set forth above, Applicants respectfully request allowance of all pending claims.

In the event that there are any questions concerning this paper, or the application in general, the Examiner is respectfully urged to telephone Applicants' undersigned representative so that prosecution of the application may be expedited.

Respectfully submitted,

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